

IN THE CLAIMS

What is claimed is:

- 1 1. A semiconductor device, comprising:
2 a wiring structure in which an upper surface of a wiring made of a
3 copper containing film is covered with an insulation film, wherein a barrier
4 film is formed covering the upper surface of the wiring and between the
5 wiring and a cap film for preventing copper diffusion.
- 1 2. The semiconductor device of claim 1, wherein:
2 the barrier film is an exposure prevention film which prevents the
3 wiring from being exposed to a film forming gas for the cap film.
- 1 3. The semiconductor device of claim 1, wherein:
2 the cap film includes an SiCN film.
- 1 4. The semiconductor device of claim 3, wherein:
2 the SiCN film is a film formed with a trimethylsilane gas, NH_3 gas,
3 and a third gas, the third gas being selected from the group consisting of
4 helium gas (He), nitrogen gas (N_2), and argon gas (Ar).
- 1 5. The semiconductor device of claim 1, wherein:
2 the barrier film is a film formed without using NH_3 gas.

1 **6.** The semiconductor device of claim 5, wherein:

2 the barrier film includes a SiC film.

1 **7.** The semiconductor device of claim 1, further including:

2 a multilayer wiring structure including a plurality of wiring layers

3 made of a copper containing film, with each wiring layer separated by a

4 respective interlayer insulation film.

1 **8.** A method of producing a semiconductor device having a wiring structure in which an

2 upper surface of a wiring made of copper or a copper alloy is covered with an insulation film,

3 comprising the step of:

4 forming a cap film, for prevention of copper diffusion, between the

5 wiring and the insulation film, and over a barrier film covering the upper

6 surface of the wiring.

1 **9.** The method of producing the semiconductor device of claim 8, further including:

2 a step of forming the barrier film without using a NH_3 gas after the

3 wiring film is formed.

1 **10.** The method of producing the semiconductor device of claim 8, wherein:

2 the barrier film includes an SiC film.

1 **11.** The method of producing the semiconductor device of claim 8, wherein:

2 the step of forming the cap film includes using a trimethylsilane gas,
3 NH₃ gas, and third gas after the barrier film is formed, the third gas being
4 selected from the group consisting of helium gas (He), nitrogen gas (N₂), and
5 argon gas (Ar).

1 **12.** The method of producing the semiconductor device of claim 11, wherein:

2 the cap film is formed by introducing the NH₃ gas after the barrier film
3 is formed by using the trimethylsilane gas and the third gas.

1 **13.** The method of producing the semiconductor device of claim 11, wherein:

2 the cap film includes a SiCN film.

1 **14.** The method of producing the semiconductor device of claim 8, wherein the barrier
2 film and the cap film are formed after the wiring is formed and further including the steps of:

3 a series of processes for forming layers of wirings, each layer of
4 wiring covered by an interlayer insulation film and including a step of forming
5 a cap film, for prevention of copper diffusion, over a barrier film covering an
6 upper surface of the layer of wiring.

1 **15.** A method of producing a semiconductor device, including the steps of:

2 forming a first wiring layer made of a copper containing film within a
3 first interlayer insulation film;

4 forming a first barrier film over an upper surface of the first wiring

5 layer;
6 forming a first cap film for preventing copper diffusion over the first
7 barrier film; and
8 forming a second interlayer insulation film over the first cap film.

1 16. The method of producing the semiconductor device of claim 15, wherein:
2 the step of forming the first barrier film does not include using a NH_3
3 gas.

1 17. The method of producing the semiconductor device of claim 15, wherein:
2 the first barrier film includes a SiC film; and
3 the first cap film includes a SiCN film.

1 18. The method of producing the semiconductor device of claim 15, wherein:
2 the step of forming the first cap film includes using a trimethylsilane
3 gas, NH_3 gas, and a third gas after the first barrier film is formed, the third gas
4 being selected from the group consisting of helium gas (He), nitrogen gas
5 (N_2), and argon gas (Ar).

1 19. The method of producing the semiconductor device of claim 18, wherein:
2 the first cap film is formed by introducing the NH_3 gas after the first
3 barrier film is formed by using the trimethylsilane gas and the third gas.

1 **20.** The method of producing the semiconductor device of claim 15, further including the
2 steps of:
3 forming a second wiring layer made of a copper containing film within
4 a third interlayer insulation film over the second interlayer insulation film;
5 forming a second barrier film over an upper surface of the second
6 wiring layer; and
7 forming a second cap film for preventing copper diffusion over the
8 second barrier film.